

IMPERIAL BUREAU OF ANIMAL NUTRITION

Technical Communication No. 13

THE FEEDING OF CAMELS

COMPILED BY

I. LEITCH, M.A., D.Sc.



IMPERIAL BUREAU OF ANIMAL NUTRITION

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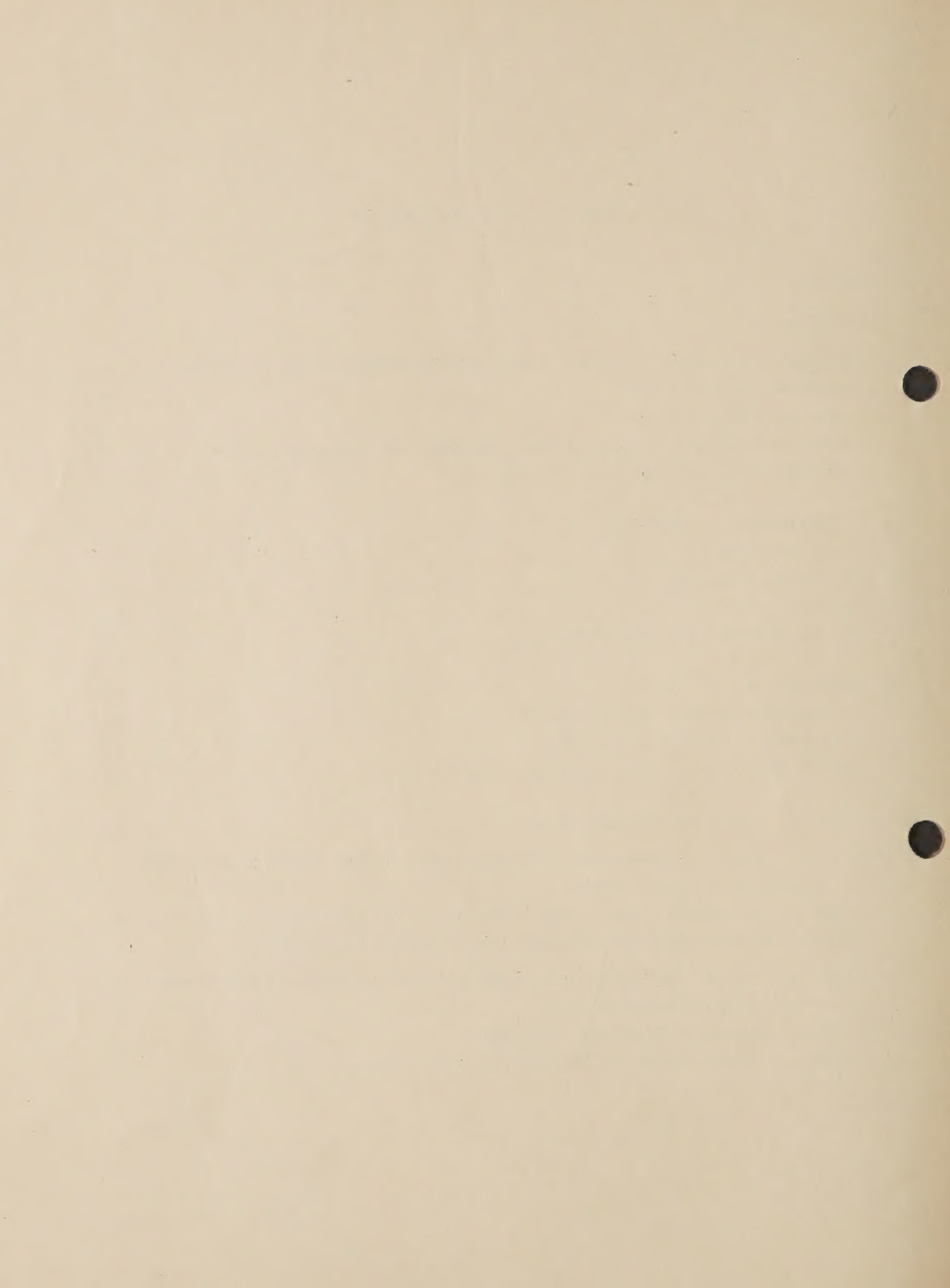
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THE FEEDING OF CAMELS.

PREFACE.

THIS Technical Communication necessarily differs from most others issued by the Imperial Bureau of Animal Nutrition in that it shows the absence of scientific knowledge, instead of reviewing it. The aim is, therefore, less to inform than to make a plea for what must surely be the most neglected of agricultural animals. There can be no doubt that, so long as the camel holds its own against mechanised transport "on the outskirts of civilisation" and there is a market for camel hair, some investigation of the food requirements of the camel would be repaid. In addition, physiological problems of salt and water metabolism, of great theoretical interest, assume in the camel a practical importance which they do not commonly have in other domestic animals. These ought to attract the physiologist.

The information to be presented here is derived chiefly from A. S. Leese's "Treatise on the One-humped Camel". Indeed, so much has been taken from this one source that it would be almost impossible, and no attempt has been made to indicate in detail in the text the extent of the indebtedness. The views there expressed on the nutrition of the camel are supported by the replies received from the Directors of Agricultural and Veterinary Services in the Sudan, Iraq, Palestine and Nigeria, to whom a questionnaire was sent from this Bureau in 1932. These replies have been freely used in the general text and in preparing the appended tables. Other sources of information are shown in the list of references.

SUMMARY.

A general outline is presented of the distribution of camels, the value of their products, their general feeding habits and food requirements. The practice with regard to salt feeding and watering is discussed.

It is suggested by expert observers that rations for work are usually inadequate and that salt deficiency is common. The salt deficiency leads to dehydration and general poor condition. It produces or favours the occurrence of other diseases, contagious necrosis and arthritis.

It is suggested that in addition to undernutrition and salt deficiency the camel may also suffer frequently from deficiency of vitamin A.

On the basis of generalised energy and production standards set up for ruminants, it is shown that rations suggested by experienced camel officers may, in some cases, be inadequate in energy value and common practice is reputed to fall far short of these standards. Rations for work which contain legumes and legume fodder or oilcake are adequate in protein, but in those containing a cereal grain as concentrate the protein is inadequate.

The relationship of salt intake to water storage in the camel is discussed and it is suggested that in addition to the results already mentioned, salt deficiency may be the cause of certain nervous disorders due to dehydration or possibly in the form of water intoxication. From estimates of the salt and water intake from different rations and allowances and with particular reference to the amount of salt supplied by saltwort grazing, it is suggested that not less than the daily allowance of 5 oz. suggested by Peck should be supplied to hand-fed camels except when they are or have recently been on saltwort pasture.

1. GENERAL INFORMATION ON CAMEL DISTRIBUTION AND FEEDING.

Distribution.—The original home of the camel, according to Leese, was in South-West Asia, and its present distribution in the world can be traced to its migrations as a domesticated animal. It is present in important numbers in three continents, Asia, Africa and Australia. Acclimatisation, he says, does not take place in a damp climate. This is partly due to the relative inefficiency of the camel for work on a muddy soil, but chiefly to its susceptibility to trypanosomiasis and its lack of defence against biting flies. In India and Africa its distribution has been largely determined by these factors.

Temperature is not an important factor directly affecting distribution. Extremes of dry heat and cold are well tolerated. It is, however, of great importance through its effect on fodder supply. Camels are bred and worked chiefly under conditions in which they are expected to find their own keep. Hence seasonal variations in herbage supply necessitate migrations and limit their usefulness.

Number.—The camel population of the world, as given in the International Yearbook of Agricultural Statistics (12) and taking the latest year for which reasonably complete estimates are presented, is over 4,600,000. Of these a million and a half are in British Somaliland, nearly a million in India, and nearly half a million in the Sudan.

Value.—It is not possible to offer any estimate of the value either of camels themselves or of their transport services or products. In Somaliland camel's milk is one of the most important human foods, and in the Sudan and other parts of East and North Africa many are kept solely for meat. The hides are not valuable for sale although they are used for saddlery and for making leathern vessels. Camel hair is used by the owners to make blankets, fabric for saddles and bags and for ropes. It is also a recent addition to luxury textiles and the market is, without doubt, capable of great expansion. In 1938, over 1 million lb. of camel hair, valued at £106,096, was imported into the United Kingdom (2).

GENERAL FEEDING HABITS.

The feeding habits of the camel differ to some extent with breed and, of necessity, vary from one locality to another. The hill camel is accustomed to an indigenous flora different from that of the plains camel. The riverine camel will not willingly eat dry grass though the desert camel will eat it readily. Most camels will eat fresh grass in the rainy season when it is young and succulent, but grass appears to be of primary importance as a fodder only in Somaliland. The camel feeds chiefly on bushes.

The number of species making up the bulk of the natural grazing is limited; the subsidiaries are innumerable. It is frequently said that the camel will eat almost anything. For that reason it is possible to accustom most breeds to unfamiliar plants or artificial feeding. On the other hand, knowledge of the nutritional requirements of the camel appears to be extremely meagre and artificial feeding has not been either rationally planned or very successful.

The chief grazing, common to all camel country, consists of acacia, salvadora, tamarisk, capparid, wild olive, zizyphus and saltbush. Under natural conditions the camel finds the salt (sodium chloride) which, in common with all other herbivorous animals, it requires as a supplement to plant food by grazing saltbush. Only hill grazing, Leese says, does not, as a rule, require this supplement. The importance of saltbush grazing for the health of the camel is known to all camel owners and, from areas where saltbush does not occur, periodic migrations to saltbush grazing are the rule. The replacement of saltbush by salt in artificial feeding and the results of salt deficiency are discussed in Parts 2 and 3.

A list of plants commonly grazed by camels and of crops regularly or occasionally used in artificial feeding has been compiled from the sources indicated in the preface (Appendix 1).

This list is known not to be exhaustive, and is presented because of the notes which have been provided on a number of the plants. These notes may make it easier for camel officers unfamiliar with the flora of a given area to judge of the value of the grazing available and to determine what additional rations may be necessary. Those plants for which analytical data have been found are marked with an asterisk and the analyses are given in Appendix 2.

A camel that is not working can subsist entirely on grazing. His hump increases from spring as long as foliage is plentiful, to the end of autumn in years of good rainfall, and decreases in winter. A working camel, expected to find most of its own feed, must graze for from 6 to 9 hours daily. Subsidiary rations are desirable even when grazing is good and, if the work is heavy, should be generous. In practice, Leese says, rations are seldom adequate, and as much time as possible should be allowed for grazing. In crossing barren country, the marches should be lengthened to shorten the period of scarcity; in good country, shortened to allow more grazing. A three-month rest period in the best grazing season is commonly allowed, and is necessary for all camels in regular work and depending for their food chiefly on grazing.

Grazing Area Required.—The carrying capacity of camel country varies with the density of the jungle or forest. Where the grazing bushes are close and where all parts are accessible, jungle will carry one resting camel to 10 acres a year or a cow and calf to 15 or 20 acres. In open jungle and desert a much larger area per camel is required. Forest that is too heavily grazed is seriously damaged and, to prevent deterioration even under normal grazing conditions, half to two-thirds of a grazing area should be closed each year and only half or one-third grazed.

It is obvious from these considerations why "the camel is at his best on the outskirts of civilisation". In densely populated or "too highly organised" areas the camel is unpopular. Grazing is to be had only by trespass or at the expense of permanent damage. From such areas periodic migration to distant grazing grounds is necessary. Although the camel could probably be maintained on artificial rations, the cost to the camel owner, who is a nomad and not a farmer, appears to be prohibitive. Nor can the camel compete under such conditions with mechanised transport.

FOOD REQUIREMENTS.

Growth.—Practically no systematic study of the food requirements of the camel has been undertaken and little information has been found on rate of growth. Leese says that a camel at 8 years of age is in very much the same state of maturity as a horse at 5 years; at 5 years a camel is still growing. The weight of a full-grown camel depends on breed. Small hill camels weigh less than 9 cwt., Somali, Arab and Sudan camels from 9 to 11 cwt., and big Indian camels from 10½ to 11 cwt. Since these weights are less than those of large breeds of horses, it would appear that the camel grows more slowly than the horse. On the other hand, the composition of camel's milk, as shown below in comparison with that of other species, indicates that provision has been made for a rate of growth greater than that of the foal and approximately the same as that of the cow.

	Approximate Average Percentage Composition of Milk.				Ash per 1000 Cals. g.	Percent. of Cals. from Protein.	Days to double Birth Weight.	Years to attain full Growth.
	Protein.	Lactose.	Fat.	Ash.				
Man .	1.5	6.8	3.5	0.2	3.7	9	180	18
Horse .	1.9	6.6	1.1	0.3	6.7	17	60	3 to 4
Camel (17)	3.7	5.8	2.9	0.6	9.1	23	Unknown	Still growing at 5
Cow .	3.5	4.8	3.5	0.7	10.5	22	47	3 to 4

The times to attain full growth given above for the horse and cow are for animals under ordinary conditions of farm management. They are not minimal nor are they greatly extended

by food shortage or imbalance. They suggest that the growth impulse of the camel may be inhibited by one or both of these possible causes of slow growth. Throughout growth the camel may be subjected to periods of food shortage and Leese's account of the rearing of young camels might also be taken to support this view. He says that, everywhere except in Australia, the amount of milk allowed to the young camel is carefully and drastically restricted. For the first 20 days the calf is allowed only one teat and, if the cow is fat and the grazing good, the calf is allowed only a small quantity of colostrum. The allowance is gradually increased until at 6 or 7 months, or earlier if the yield is small, all the milk is taken by the calf. Although it might be thought that the restriction was designed for the benefit of the camel owner, who himself uses the surplus of 1 to 2 gallons daily, this would not apply to the colostrum period, since colostrum is not used for human consumption. The first few weeks are regarded as the most critical of the calf's life, and it is said that the calf that gets too much milk is liable to get diarrhoea and die. But, in Australia, where restriction of suckling is not practised, there does not appear to be any excessively high mortality.

The Australian experience and the fact that the camel is not intensively fed make it seem unlikely that the camel usually produces a large surplus of milk over the amount that could be utilised for growth by the calf. The view that the first few weeks of life are a critical period is in accordance with the general experience in rearing farm stock. The most common cause of mortality in suckling farm animals is digestive upset, appearing most often where the physiological anaemia of the young mammal has been allowed to become acute. The most effective preventive is a supplement of iron. The history of diarrhoea in the young camel suggests that the course of events may be similar. It is difficult to understand the belief that restriction of the milk supply prevents trouble on any basis other than that the limitation of rate of growth might also limit the degree of anaemia developing. An interesting investigation along these lines might be made. Restricted suckling might have an indirect action by encouraging the calf to graze earlier than it otherwise would, which would also have a curative effect by supplying additional iron.

The calf starts grazing at from 4 to 6 weeks of age and is usually grazing well before weaning. Under poor grazing conditions, lactation continues for only 8 months, but may last for up to 18 months or 2 years under good conditions. It is customary to wean at about 15 months of age so as not to prejudice milk yield in the next lactation.

Reproduction and Lactation.—A cow calves usually every second year and the gestation period is just over 12 months. Under very favourable conditions of grazing with supplementary feeding, oestrus may occur as early as 3 to 4 weeks after calving. There may then be a calf in each of two successive years with continuous lactation. But the milk yield will be less than when a dry period is allowed and the cow will be in poor condition at the end.

Breeding may start at 3 years of age but is not usually allowed until a year later since it checks growth. It continues up to 20 years of age or later. Sterility is uncommon but abortion is frequent in Indian camels and is usually due to food shortage or to trypanosomiasis.

Bulls are not usually used for breeding until they are 8 years of age. It is customary to give them "tonics" during the breeding season: 2 lb. of ghee or a dose of tumeric two or three times a month.

So far, there is little evidence of any planned basis for camel feeding. There are certain indications that the camel is capable of a higher rate of production than that usually demanded. The usual rate is suited to the haphazard and variable feeding conditions. Rations capable of sustaining a higher rate of production, although they could no doubt be planned, are not in use.

Work.—When the camel is working, and especially if grazing time is limited, it is given supplements of green or dry fodder, roots or grain. In India the green forage crops are legumes or *Brassicae*. Turnip roots are also fed. In addition, green cereal crops, leaves of

cotton plants, branches of trees and weeds are used. In Egypt, berseem (*Trifolium alexandrinum*), which is grown extensively on irrigated land, is an important spring feed. The crops may be grazed or hand fed. In Somaliland and Jubaland there are no forage crops for camels.

Dry fodders include straw, the sun-dried culms and vines of leguminous forage crops, and the sun-dried leaves of trees and bushes. Leese considers the legume fodder to be the most valuable staple winter feed and much superior to wheat straw which forms part of the regular ration of the Indian Government Camel Corps. The culms of gram and cluster bean are widely used. Stalks of millet, chaff and other crop residues are also fed, but they are not very palatable and their feeding value is low. Leaves of jujube trees, camel thorn and saltbush are dried and conserved for winter feed.

In camel corps rations, legumes are fed in amounts of from 2 to 8 lb. per head daily. Millet, barley and other cereals are used in similar amounts, millet especially in Africa. Dried dates, with the stones crushed, are given in N. Africa and Persia. Oilcakes of taramira seed (*Brassica eruca*) in India and of simsim (*Sesamum indicum*) in Africa, are sometimes fed in amounts of 3 or 4 lb.

Tonic balls are occasionally given to camels doing hard work. These balls are of two kinds, "food" and medicinal. The former sometimes consist of a mixture of coarse brown sugar 2 parts, wheat flour 2 parts and ghee 1 part. Dates and legumes may be included. The feeding of dried fish or mutton is also reported. The medicinal balls consist of carminatives, bitter tonics and salt.

RATIONS.

Food Quantities.—Little experimental work with camels appears to have been recorded. Cross (6), who agrees with Leese that working camels are usually inadequately fed, recorded the daily food consumption of groups of resting camels which were given test rations in addition to poor browsing. The average quantities eaten are shown in Table 4. The average total weight of the test rations consumed varied from 22.2 lb. of a dry ration of gram and hay to 135.4 lb. of cut green sarson. The quantities do not appear to be equivalent on a dry matter basis but to depend largely on the palatability of the ration. For instance, the quantity of straw eaten when missa bhusa alone was given was 24.9 lb. and it was reduced by less than 2 lb. when 6 lb. gram was fed and by just over 4 lb. with 12 lb. gram. The amounts eaten, Cross says, were, in all cases, greater than would usually be fed to working camels and, since the camels were resting and infected with trypanosomiasis, which is said to reduce appetite, the view that rations are usually inadequate seems to be justified. The Indian Government ration (see Table 6) of 16 lb. of a mixture of wheat and legume straws is "only half a ration."

Leese presents a number of rations for working camels (Table 5). Those which are intended to be fed when little grazing is available should be directly comparable with Cross's data.

In order the better to be able to compare these rations and, later, to discuss them in relation to theoretical requirements, an attempt has been made to estimate their nutritive value. No data exist for the digestibility of foodstuffs by camels, but, since the camel is a ruminant, it is not likely that any great error will be introduced by using digestibility coefficients determined with other ruminants. Data were found (Appendix 2: Table 3) for all the fodders except missa bhusa, as defined by Leese. According to him, missa bhusa is the hay or straw of *Phaseolus aconitifolius* (moth) or *Phaseolus mungo* (mung) and no digestibility studies with these have been found. Cross defines missa bhusa as the straw of *Cicer arietinum* (Bengal gram) and in the rations where it is used it has been analysed as such. In Cross's rations with moth bhusa the analysis of hay (Punjab) has been used. This substitution does not materially affect the result.

Energy Value.—Leese allows for the resting camel from 21,000 to 28,000 Cals. (see pp. 14 and 31, 32 and 33) daily without grazing. Cross's experimental camels ate, in addition to poor grazing, quantities of food giving about 16,000 Cals. when the hand-fed ration was of green fodder or straw alone or green fodder with a concentrate, 24,500 Cals. with hay alone and between 22,000 and 30,000 Cals. with dry fodder and a concentrate. Resting camels are expected to improve in condition and it may be supposed that they would do so on the higher of these rations.

For working camels when no grazing is available, Leese allows about 30,000 Cals. in each of 3 rations, 22,000 to 25,000 Cals. in four and 46,000 Cals. for working baggagers in Asia Minor. These are large camels and are recorded as carrying the heaviest loads. With a little grazing the allowance is about 22,000 Cals.; with fair grazing 17,500 Cals. and with good or full grazing, between 8000 and 11,000 Cals. The energy value of a day's good grazing, less 6 working hours, must therefore be from 14,000 to 20,000 Cals., and a full day's good grazing would be higher, values which correspond well with those given in the preceding paragraph for resting camels.

Protein.—It might be thought that rations in which the concentrate is a dried legume would provide an excess of protein but a long-term feeding experiment by Peck (25) in which half the gram of the Somaliland Camel Corps ration was replaced by sorghum, showed no advantage in condition, health or efficiency. The two rations are compared in Table 6.

The energy values and protein contents of the rations as shown in Tables 4, 5 and 6 are discussed below, pp. 14 and 15, in relation to theoretical requirements.

It is of interest also to compare these rations with feeding practices as recorded by the Directors of Agricultural and Veterinary Services in 1932. In Palestine, the Fellahin give an evening ration of from 2.5 to 4 kg., averaging about 3 kg., of "grain" and 7 to 10 kg. of straw with an average energy value of 24,000 Cals. The grain is barley, lentils, beans or the local products kersenneh and gilbaneh. We have been unable to identify these. In Iraq, the nomad Arab camel owners and transport contractors provide rations only when grazing is scarce or speed required. Then they give balls of barley meal and salt, with straw to appetite. The amounts calculated as necessary for a camel in full work are barley meal 5 kg. and straw 7 kg. giving 27,500 Cals. The grain allowances provided by native camel owners are higher and the roughage allowances lower than most of those suggested by Leese.

The ration of the Trans-Jordan Frontier Force is given as barley 3 kg., hay 5 kg. and straw 3 kg. (23,500 Cals.); of Army and Government camels in the Sudan as up to 10 lb. millet, in two or more feeds, with hay and straw; and of the Somaliland Camel Corps (Peck) as split gram 4 lb., and wheat bran 2 lb. with 10 lb. hay (16,000 Cals.).

Lenox-Conyngham, in his small handbook for army camel officers (19), says that 6 lb. grain (8000 Cals.) is a good ration for camels getting 6 to 8 hours' grazing. Hay and bhusa do very well as an additional ration but cannot take the place of grazing. When there is no grazing, 50 lb. hay daily (41,000 Cals.) should be given. Not more than 15 lb. bhusa should be allowed at a time; more than that is liable to cause digestive disturbances, with diarrhoea and tympanitis. These rations are included in Table 6.

Salt.—The rations prescribed by Leese have an allowance of 1.5 oz. of salt daily. Leese states elsewhere that camels should have 1.5 or 2 oz. daily or $4\frac{1}{2}$ to 6 oz. every third day. Salt is not necessary, he says, when the camel is on saltbush grazing. A third or more of the grazing time should be on saltbush.

Practice in Camel Corps varies. The Trans-Jordan Frontier Force and the Somaliland Camel Corps are reported to feed 1 oz. daily; the Sudan Defence Force $2\frac{1}{2}$ oz. Native practice also is not uniform. The Fellahin give salt, 1 or 2 oz. daily, to camels that are off their feed or to induce them to drink in winter; in Iraq salt is given only when no saltbush and no salt lick is available, and then only in quantities of about 20 g. daily; in the Sudan, Arab camel owners give large quantities at long intervals, $\frac{1}{2}$ to 1 lb. in water at the beginning and end of the rains, or even occasionally amounts so large as to produce symptoms of poisoning.

In Nigeria native camel owners feed crude salts "fairly regularly". When green fodder is available a crude salt is fed, 3 double handfuls once a week. When no green fodder is to be had, 1 double handful of common salt is given every 20 days. If salt is not fed, the camels lose weight and develop a pica for earth or ant hill.

Recently, in an extensive series of experiments, Peck has shown that the usual allowance of salt to hand-fed camels is inadequate. Setting out to investigate the loss of "bloom" in animals recently recruited to the Somaliland Camel Corps and the cause of contagious necrosis, which is responsible for much loss of efficiency, he fed a compound salt mixture to some and crude salt *ad lib.* to others. The compound salt mixture produced no result beyond what could be attributed to the NaCl it contained, but the results of the salt experiments are of outstanding interest. A graph is given to show the salt consumption on consecutive days. Starting with nearly 1 lb. on the first day, consumption decreased gradually until it became stabilised in a cycle closely related to watering. Immediately after watering, it was between 5 and 6 oz., and on subsequent days decreased to about 3.5 oz. for two days before the next watering. Peck therefore suggests a daily ration of 5 oz. and says that, even with that amount, the camels will still take saltbush readily.

There was a dramatic improvement in condition and health with the increased salt ration. There must have been a greatly improved utilisation of food because, he says, it was possible to decrease the gram ration by 25 per cent. No evidence was found to indicate that any inorganic substance other than NaCl was present, either in the crude salt or saltbush, to which the improvement could be attributed.

The physiological significance of these findings is discussed in the third section, pp. 15-18.

Water.—Correct practice in watering is defined by Leese as follows: "Water as often as you can unless there are frequent stages in which no water is available; in that case, train the camels to the necessary interval". On the other hand, Lenox-Conyngham condemns the idea of training. It is a common belief, he says, that it is a good thing to practice withholding food and water. "Of course this is a fatal mistake. The wretched camel, worn out by a series of more or less protracted rehearsals, breaks down completely at the real performance". Camels at work, he goes on, do best when watered every second day. With plenty green grazing, they can go without water for longer than that, but nothing is gained by withholding water when it can be got. "If they do not want it they will not drink it, and you are in no way increasing their powers of enduring without it on some future emergency by preventing them from having it when they do want it and can get it."

The quantity required depends on the amount of moisture in the food, the temperature and the work done. In the rainy season herds will go for long periods without water other than that of the herbage eaten. During the dry season, camels are usually watered at intervals of from 3 to 7 days, or oftener if they are working.

When watered daily camels will drink from 3 to 8 gallons. A camel doing forced marches in heat drinks 9 or 10 gallons every second day. After a long thirst, as much as 20 gallons may be taken.

Leese records feats of endurance which, he hopes, "only necessity will persuade anyone to emulate": 8 days' hard marching under loads of 5 maunds (over 400 lb.) without water; 537 miles in 34 days without a drink (a few survived); 8 days at 28 miles daily without water; and 17 days at 23 miles daily with only one drink.

2. NUTRITIONAL DISEASES.

SALT DEFICIENCY.

Failure to supply saltbush grazing or salt to camels rapidly results in loss of condition. The first sign that salt grazing is required is a dry tight skin. The hair tends to fall. These

facts, according to Leese, are common knowledge. He records also that camelmen say that, if salt is withheld, camels become affected with abscesses. He considers that salt deficiency may be a predisposing cause of arthritis and says that natives consider saltbush beneficial in that condition.

Confirmation for these beliefs has been supplied in Peck's salt feeding experiments, of which a full account has recently been published (24). Contagious necrosis, which caused much loss of working time and efficiency, disappeared and arthritis with it when the 5 oz. salt ration was fed.

It is well known in animal husbandry that an inadequate supply of salt affects the utilisation of food, and hence general condition and produces a characteristic hide-bound appearance. But the effect on health appears to be even more obvious in the camel than in other ruminants. The metabolism of salt and that of water are intimately associated, and this fact is recognised and even exploited (p. 16) by native camel owners. The retention of water in the body is largely governed by the supply of salt and, since the ability to withstand water deprivation is one of the camel's most valuable assets, the adequacy of the salt supply is a consideration of the first importance.

For these reasons, further evidence has been sought on salt requirements. Leese says that a third of the grazing time should be on saltbush. Analyses of some African saltbushes have been found. These are *Salsola glabrescens* and *Salsola aphylla*, *Atriplex capensis*, *nummularia*, *semibaccata* and *halimoides*. The range of salt content is wide. It is higher in *Atriplex* than in *Salsola* and the two *Salsola* species differ in that one has a high sodium and the other a high potassium content. Table 2 shows the percentage ash composition and estimated NaCl value of these saltbushes.

On the assumption that the energy value of the saltbush grazed in a given time would be approximately equal to that of other grazing, an assumption warranted by Henrici's analyses (cf. Tables 1 and 2), which have been used, and that a total intake of 30,000 Cals. daily is required for working camels, it has been calculated that the *Salsola* of lower salt content would yield about 90 g., and that of higher salt content 135 g. NaCl in a third of the grazing day. *Atriplex* grazing would yield between 280 g. and 400 g. daily. For comparison, the usual salt ration of 1.5 oz. daily provides 42.5 g. and Peck's ration of 5 oz. crude salt is equivalent to 123 g. NaCl.

SALTWORT PARALYSIS.

This disease affords a direct contrast to salt deficiency. Leese describes it as indigenous only in one locality, the sandy desert of the Sind Sagar Doab between the rivers Indus and Jhelum. He suggests that it may occur also in Algeria. In the centre of the indigenous area the camels graze only saltwort, Bagga lana (*Salsola foetida*) and Khar lana (*Haloxylon recurvum*). If this grazing is intermittent only, the camels moving into and out of the area at intervals of a few days, or if they remain in the central area only during the cold weather, no harm results. But, if they graze only saltwort in the hot weather and do so year after year, then they ultimately develop saltwort paralysis.

The condition is seldom seen, before the camels are 6 years old. They are then emaciated, weak and anaemic, but do not lose their appetite. Finally, difficulties of locomotion, "paralysis", occur and the animals die of exhaustion. Removal from the area after 5 years of age may prevent full development of the condition but health is never restored.

The characteristic and constant post-mortem findings are extreme emaciation and anasarca (general dropsy). All the muscles are oedematous; the blood appears thin and watery and may not clot. There is subcutaneous oedema along the back; the walls of the fourth stomach and intestine and the mesenteric glands may be oedematous and there may be as much as 2 gallons of fluid in the peritoneal cavity.

It has been stated that the vitamin C content of the milk of camels is so high that the milk is both prophylactic and curative of scurvy (7). This observation is so surprising, in view of the usually low vitamin C content of milk, that a study of the vitamin C content of plants grazed by camels, especially perhaps the saltbushes, would be of great interest.

GOITRE.

Goitre occurs in camels but no information is given as to its distribution or frequency. Large congenital goitres sometimes occur when the dam has been kept confined, as on ship-board or in Zoological gardens.

OTHER POSSIBLE NUTRITIONAL DISEASES.

Since so little is known of the camel's nutritional requirements and its food supply has received so little attention, the suggestion is made that the following impressive list of common diseases of the camel point to a possible common vitamin A deficiency.

1. Acute conjunctivitis, keratitis and ophthalmia, sometimes without detectable injury : the ophthalmia may lead to blindness from atrophy or rupture of the eyeball. Night blindness may make night riding dangerous or impossible.
2. "Elbow-brushing". (Hyperkeratosis?). The occurrence of large areas of horny or "woody" overgrowth of the epidermis, in camels in poor condition and overloaded. The condition may arise in any of the areas where friction can occur. It is extremely resistant to local treatment and may be invaliding.
3. Suppurative conditions associated with the upper respiratory passages, sub-maxillary glands and ears.

Most of the conditions under the first three headings are stated by Leese to be due, usually, to injuries, but the descriptions are so suggestive of acute vitamin A deficiency that an experimental attempt to improve therapy by early treatment with large doses of vitamin A would at least be interesting and might be very important.

4. Respiratory diseases : cold, "influenza", pneumonia.

It is repeatedly stated that the camel is particularly liable to disease of all kinds when it is fed on dry rations, especially bhusa with insufficient grazing. Poor condition appears to be a recognised predisposing cause of infective disease. In particular, it is known to favour the spread of the skin diseases, mange and contagious necrosis, and was the cause of the "dietetic eczema" which occurred in older military expeditions. Even the course of trypanosomiasis is affected by diet. Leese says that rest and good food will enable animals to throw off an attack which, with hard work and poor feeding, would be fatal.

3. DISCUSSION.

THEORETICAL ENERGY REQUIREMENTS.

Basal.—No direct estimates of the basal metabolic rate of the camel have been made. But, since the same general law relates B.M.R. to bodyweight in mature mammals, the values given by Benedict (3a) for cattle have been taken to indicate that a camel of 1000 lb. live-weight would have a basal energy expenditure of about 300 Cals. per hour or 7200 Cals. daily. That of the 1200 lb. baggage camel would be about 350 Cals. per hour or 8400 Cals. per day.

Maintenance.—According to Brody, the maintenance requirement of the adult ruminant is of the order of twice basal (4). As a first approximation, therefore, that of the 1000 lb. camel may be taken as 14,400 Cals. and that of the 1200 lb. camel is 16,800 Cals. daily.

Work.—From extensive observations on energy expenditure during work in different species, Brody concludes that the same general laws govern expenditure, regardless of size.

If this view be accepted, then his findings may be applied to estimate the possible requirement of the camel. The standard rate of energy expenditure, during sustained work, he says (5), is of the order of 8 times the basal metabolic rate.

The amount of work that a camel is expected to perform under normal conditions is definable within fairly narrow limits. The Somali camel, weighing 1000 lb., carries a load of 240 lb. at a pace of 2.5 miles per hour, and is marched for 6 hours. Heavy baggagers, weighing 1200 lb., take 400 to 650 lb. for a normal march, but may take up to 950 lb. for short distances, or the march may, on occasion, be as long as 20 miles, *i.e.*, 8 hours.

Taking the load of 240 lb. and a 6 hours march as representing the standard rate of energy expenditure during sustained work, the total energy requirement of the 1000 lb. camel may be calculated as follows: maintenance for 18 hours at twice B.M.R. = 10,800 Cals.; work for 6 hours at eight times B.M.R. = 14,400 Cals.: total 25,200 Cals. Similarly for the 1200 lb. camel working at the standard rate, the requirement would be: maintenance 12,600 Cals.; work 16,800 Cals.: total 29,400 Cals. Since the load may be doubled or the march increased by a third, and since the heaviest camels weigh up to 1500 lb., the maximum daily requirements may be of the order of 30,000 Cals. for the lighter camels and 40,000 to 50,000 Cals. daily for the heavier.

Resting.—It will be remembered that the resting camel is expected to improve in condition. The hump increases from spring to autumn. The weight of fat in a hump should be about 80 lb. (22). Supposing that half this weight, in addition to subcutaneous fat and fat in other parts of the body, is to be put on during the three rest months, it might be supposed that weight gain would be at the rate of 1 lb. daily or more. Calculated on the basis of rations for farm stock this would require a surplus over maintenance of not less than 5000 Cals. daily and might require twice that amount.

Comparison with Rations.—The following table shows these estimates along with the corresponding calculated ration values, as shown in detail in Tables 4, 5 and 6.

Estimated theoretical daily requirements : Thou. Cals.	Estimated daily value of rations : Thou. Cals.			
Camels of 9 to 11 cwt.	Cross.	Leese.	Native Camel Owners.	Camel Corps.
Resting camel, putting on hump : 19.4 to 21.8 or more	15.7 to 31.4	21.0 to 28.4	—	—
Work at standard rate : 25.2 to 29.4	—	21.9 to 45.9 with little or no grazing	24.1 and 27.5 with poor grazing	(10.1) 15.9 and 23.5 with grazing.
Heavy work : 30.0 to 50.0	—			

It will be seen that the data, although not entirely consistent, are on the whole in good agreement. Cross's camels ate more than their theoretical requirement, but this might be explained as due to the trypanosomiasis infection. The energy requirements of heavy work appear to be met by Leese's rations, but light weight camels doing standard work would not have their work expenditure covered unless "little or no grazing" is credited with a value of about 3000 Cals. daily. The adequacy of the Camel Corps rations (excluding the Indian Government fodder ration of straw alone, 10,100 Cals.) would depend on the amount of grazing secured. It is suggested that this theoretical basis might be used in practice as a basis for calculating rations.

The fat of the hump alone represents an energy value of about 338,000 Cals. If it could all be mobilised in so short a time it would provide the equivalent of work rations for from 7 to 10 days.

THEORETICAL PROTEIN REQUIREMENTS.

Brody has suggested a generalised maintenance standard for protein for farm animals such that the protein supplies 10 per cent. of the calories (4). It is not known with certainty whether the requirement is increased in heavy work, but there is no evidence to show that it is less. Hence it may be taken that the supply should not fall below what will correspond to 10 per cent. of the calorie value of the total diet. It will be seen from Tables 4, 5 and 6 that the protein content of the rations varies from 2 per cent. for straw alone to about 20 per cent. for the two rations with oilcake. The rations with gram and missa bhusa, gram and barley, gram and green fodder and green fodder alone all exceed 10 per cent. It will be seen also from Table 1 that in all the fodder plants shown there, except a few samples of straw and husk, more than 10 per cent. of the energy value is derived from protein. The stems and leaves of *Acacia arabica* give a value of 16, the leaves of *Zizyphus* 16 and those of *Boscia* 33 per cent. The green fodder plants exceed 20 and sometimes 30 per cent.; the saltworts all exceed 28 per cent. It may be inferred that the camel, under natural conditions, has a high protein intake and that, when hand fed on rations, without grazing, they may suffer a great decrease.

WATER STORAGE: ITS RELATIONSHIP TO SALT INTAKE.

The Functions of Water in the Body.—Adequate storage of water in the body is essential to all the metabolic processes. It is required for the digestion and absorption of food, for the transport of material within the body, for the normal functioning of all tissues, including the sense organs, and for the excretion of waste products (1). It acts as a buffering fluid in synovial cavities and tendon sheaths. It is the most important means of dissipating heat by evaporation from the lungs and skin and of protecting the body against changes of temperature (26).

It needs no emphasis that the role of water assumes especial importance in an animal whose claim to distinction lies in its ability to withstand and to perform work under conditions of great heat in arid regions. In spite of the insulation afforded by its coat of hair, which is thin in the tropics, the possession of an adequate store of water must play a large part in maintaining its resistance to heat.

Absorption and Storage.—Water taken without food and without salt is rapidly excreted unless the tissue fluids already have a concentration of salt higher than the normal concentration in the blood plasma (3). Isotonic salt solution passes rapidly into the tissues and, in sufficient quantities, may cause visible oedema of the skin in man (1). When a hypertonic salt solution is drunk, salt is removed from the blood by the tissues and if water is subsequently taken, it will be retained in the tissues to dilute the concentrated solution there with resultant oedema. Storage is chiefly in the muscles and skin (20, 26). If the concentration in the tissues falls below that normal for plasma, it is readjusted by elimination of water and, if such readjustments are repeated, a state of dehydration results.

Rowntree in his review of "The Water Balance of the Body" (26) says that the camel "has a system of stomachs most capacious and effective for carrying its water supply . . . and a digestive tract that wastes no fluid, and permits dry stools only." Both statements appear to be in error.

It is popularly believed that the camel stores water in two pouches which arise from the rumen. Leese, however, regards this as a fable and, on the basis of post-mortem examinations, believes that the pouches, which resemble the reticulum in structure, serve to moisten the food which is to be masticated during rumination. By doing so they render the animal

less dependent on a regular supply of water with its food. It seems very likely (see below) that the stories of travellers who have saved their lives by killing their camels to get water from the water sacs, arise from the presence in the stomachs, not of stored water, but of water mobilised from the body in digestive secretions.

Normal camel dung, Leese says, is in pellets about the size of a walnut. The consistency depends on the diet. Diarrhoea is very easily induced, for instance by certain types of grazing or sudden changes in diet, and constipation with hard dry pellets is characteristic of certain forms of disorder.

The most striking feature of water absorption and storage in the camel is the ease with which the process can be observed. If the supply of salt is adequate, but not otherwise, the giving of water results in a definite subcutaneous oedema. The presence of this oedema is the normal physiological state. A watery discharge from the nostrils may occur. Surely, in the presence of such indications, there is no excuse for the salt-starved dehydrated camel. The ability of the camel to store away a large quantity of water in this way is exploited by native camel owners, who, when they wish to sell an animal in poor condition, give it first a large dose of salt and then water. The accumulation of water under the skin may make it appear in good condition. But it does not seem to have been used as a simple indication of the adequacy of the salt ration.

In addition to this subcutaneous store there will also be a large reserve in the muscles which can be drawn upon in case of need, and the fat of the hump represents a store of water as well as of food (see next paragraph). The only record found (22) of the analysis of a hump gave 80 lb. of fat. This would represent an emergency supply of 8 gallons of water to be liberated gradually as the fat is used.

Circulation and Loss.—Much more water is “metabolised” in the body than is taken as drink. There is the water present in foodstuffs, *i.e.*, the “preformed” water of the diet, and that which arises from the constituents of food when they are metabolised in the body (20). The burning of 1 g. of fat in the body gives rise to about 1 g. of water; 1 g. of carbohydrate to about 0.6 g. water and 1 g. of protein to about 0.4 g. water. This water of metabolism may form a large part of the total turnover.

During digestion large volumes of water are poured into the digestive tract in saliva and in the gastric and intestinal secretions. In man, the amount of water so withdrawn from the body in a day exceeds by 2 or 3 times the amount taken in food and drink (25). It is reabsorbed and, unless vomiting or diarrhoea is present, there is little or no loss. The chloride present in the gastric secretion is also reabsorbed without loss except when vomiting occurs.

Reference has already been made to the possible significance of the circulation of digestive secretions in providing water in the stomach sacs.

Continuous loss occurs through the kidney, the amount depending on the intake, the concentration of salt in the body, and the loss through other channels. In great heat or during strenuous muscular exercise, more water is vaporised from the skin and lungs to dissipate heat and less is excreted by the kidney. The loss of salt through the kidney is slow, but when sweating replaces renal excretion during hard exercise, a much more rapid loss of salt occurs. This loss in the absence of a compensating high intake is cumulative and leads to tissue depletion (8). The normal concentration in the tissues is maintained as long as possible by the elimination of water and so dehydration of the tissues results.

Peck says that the Somaliland riding camel rarely perspires but most camels do, and Leese says they may come from the grazing ground in the evening damp with perspiration. When evaporation from the skin is prevented, for instance by oiling the skin in the treatment of mange, a rise of temperature occurs and subcutaneous oedema may be observed. The loss of water is therefore possibly very high during work in hot weather. In the hand-fed camel doing hard work with little or no saltwort grazing and small salt rations, it seems very likely that tissue depletion is common.

Water and Salt Deprivation.—A starving animal can lose all its glycogen and fat and half of its body protein, totalling about 40 per cent. of the bodyweight, without fatal results, but a loss of 10 per cent. of the normal water content will lead to serious disturbances and the loss of 20 per cent. may be fatal (26).

Lack of sufficient salt prevents storage of water in the body and leads to dehydration. The most obvious effect is on the skin, which becomes dry and inelastic (20). McCance has described the results of voluntary salt deprivation in man. Water drinking was not restricted. Of particular interest is the effect on muscle action. "Any muscle suddenly brought into action was liable to spasm."

The resistance of the camel to deprivation of water and the common occurrence of the well-known signs of salt deficiency have been discussed. The dependence of power to resist deprivation of water on an adequate supply of salt is probably not sufficiently well recognised. It has been seen that susceptibility to skin diseases and to arthritis are conditioned by salt starvation and the accompanying dehydration. The observation on arthritis is of particular interest in view of the post-mortem finding of decreased synovial fluid (25). It might be suggested further that some of the obscure "nervous diseases" which occur in the camel and for which no explanation has been offered may be due to chronic salt starvation and dehydration. The prominence of muscle symptoms, twitching and shivering and of hyper-irritability lend support to the suggestion. The conditions under which they arise are, however, not well defined and no metabolic studies nor studies of blood chemistry have been made from which deductions could be drawn.

Water Intoxication.—When considerable losses of water and salt from the body have occurred as the result of sweating during prolonged or repeated exercise in heat, and the loss of water is made good by drinking water without salt, the first result is a state of fatigue and depression and, when the condition is more advanced, acute cramps occur (8, 26). This is known in man as miner's or fireman's cramp. Produced rapidly under experimental conditions in dogs, water intoxication is shown by muscle twitchings, convulsions and ataxia with panting respiration and progresses to stupor and unconsciousness (29). The convulsions may be due to cerebral oedema (21).

In the camel there is one particular condition, the disease known as "mad staggers," in which the occurrence, the mode of onset and the rapid and complete recovery suggest the possibility that it may be due to water intoxication. It occurs typically in grain-fed camels in good condition, after a long march in hot weather, when they have quenched their thirst and are given their feed of grain in the evening. If it be assumed, as seems likely, since most hand-fed camels are inadequately supplied with salt, that the camel is allowed to drink without salt, the exact conditions for producing the condition are present. The onset is abrupt. The camel is at first restless, alarmed, with staring eyes. Then he suddenly "runs amok," quite blind, and lifting his legs with exaggerated action. Sometimes he may fall and remain still for a few minutes, blowing hard; then he may rise and run again. He may fall and die or he may be found peacefully grazing next morning. It is difficult to compare that picture with the symptoms shown by dogs confined in cages. In them recovery was rapid and complete. Had the dogs been at liberty it would have been easier to make a comparison. The suggestion may, of course, be wrong, but water intoxication would be expected to occur in animals which are salt starved and quench their thirst by large draughts of water at long intervals.

Salt Requirement.—It remains to attempt to make final deductions regarding the salt requirement of the camel. The normal salt content of mammalian plasma is about 0.6 or 0.7 per cent. If the concentration of salt in food as a percentage of the total fluid from the ration exceeds this level, salt will be stored. According to Hancock *et al.* (8), when the tissues are depleted so that there is danger of water intoxications from drinking unsalted water, a concentration in the water of 0.25 per cent. will prevent toxic symptoms.

In Table 7, the concentrations of salt in water from a typical "dry" ration with different allowances of salt and drinking water and in a ration consisting partly of fresh green sarson and partly of saltworts of different salt content have been calculated. It will be seen that a ration of hay and gram with 1.5 oz. salt and 3 gallons of water will give a concentration of 0.54 per cent. of salt; with 8 gallons of water 0.23 per cent. That is to say, this ration is just about adequate, with 8 gallons of water to prevent intoxication; with 3 gallons of water, it would still be below plasma concentration. A 5 oz. ration of salt would give a concentration of 0.48 per cent. in the one case and 1.1 per cent. in the other, *i.e.*, with 8 gallons of water, it would prevent intoxication and with 3 gallons it would permit salt storage. Peck does not record the amount of water drunk with the 5 oz. salt ration, but it would certainly be above 3 gallons and might even be above 8 gallons because the salt would increase thirst.

Finally, with the large ration of fresh fodder, the *Salsola* richer in salt would provide enough to prevent intoxication but not enough to cause storage; *Atriplex halimoides* would provide an isotonic solution. A reduction of the sarson in the ration and an increase of the *Atriplex* would give a concentration at which storage would occur.

From the clinical data already presented and these calculations, especially the comparison with saltwort grazing, the conclusion seems justified that the salt allowance, in the absence of saltwort grazing, should not be less than Peck's ration of 5 oz. If storage is desired, considerably more might be given. A ration of 5 oz. is, in fact, less than that voluntarily taken by milk cows over a lactation period (average 7 oz.) (28) and, in relation to bodyweight, not much higher than that commonly fed to growing pigs (32).

Salt Excess.—Any of the saltworts grazed alone gives a concentration of salt high enough to cause tissue storage of salt. The lowest, *Salsola aphylla*, gives 1.0 and the highest, *Atriplex halimoides*, 3.9 per cent. For direct comparison, there is a description of an outbreak of salt poisoning in cattle in Australia (24) caused by drinking bore water containing approximately 1.4 per cent. of NaCl. Some of the animals died. The chief symptoms were nasal discharge, paresis, loss of condition and emaciation. It may be deduced that the camel's tolerance for salt is higher than that of farm ruminants since it requires several years' saltwort grazing, continued in hot weather when the salt concentration in the plants is highest, to produce saltwort paralysis. The similarity of the symptoms supports the suggestion that saltwort paralysis may be due simply to chronic excess ingestion of salt.

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APPENDIX I.

LIST OF CAMEL FODDER PLANTS WITH SOME NOTES ON THEIR VALUE AS GRAZING.

TREES, SHRUBS AND GREEN FODDER PLANTS.

<i>Botanical Name.</i>	<i>Area.</i>	<i>Notes.</i>
ACACIA [Leguminosae]		
albida *	Sudan, Nigeria	Young shoots and fruits eaten with relish.
arabica *	N. Africa, India	Good grazing for most of year: of special value in drought. Fruits much appreciated.
catechu	India	
decurrens	Australia	
ehrenbergiana	Sudan	Scrub of N.E. deserts: common camel fodder there.
kerugera	Sudan	S. of 12th parallel. Eaten when no other grazing available.
leucophloea	India	
mellifera	Sudan	Central. Young shoots. Not highly esteemed.
modesta	India	Important in hot weather.
nubica	Sudan	Inferior food.
seyal	Sudan	S. of 14th parallel. Eaten sparsely.
sieberiana *	Nigeria	
spirocarpa *	Sudan	N. of 13th parallel. Pods eaten avidly.
tortilis	Sudan	
verek	Sudan	
ACHILLEA [Compositae]	Iraq	A. vermicularis Trin., santolina L., falcata L. var. brevibradiata Boiss are eaten.
ADANSONIA [Bombacaceae]		
digitata *	Sudan	Leaves readily eaten in early rains.
ALBIZZIA [Leguminosae]		
lebbek	India	
ALHAGI [Leguminosae]		
maurorum Medic	Iraq, India	Camel thorn; very good in hot weather; dries up quickly in cold season.
ASTRAGALUS sp. [Leguminosae]		
	Iraq	

* See Table of Analyses.

<i>Botanical Name.</i>	<i>Area.</i>	<i>Notes.</i>
AVICENNIA [Verbenaceae] officinalis	India	Mangrove. Grazed for six hottest months in the year.
BALANITES [Simarubaceae] aegyptiaca *	Sudan	Leaves and shoots; fruit is slightly bitter and a mild purgative.
BAUHINIA [Leguminosae] reticulata * rufescens *	Nigeria Sudan, Kordofan, Darfur	Pods valuable fodder. Excellent food and greedily eaten.
BOERHAAVIA [Nyctaginaceae] diffusa	India	A weed found in Jowari fields in the monsoon season. Should be fed sparingly at first.
BOSCIA [Capparidaceae] octandra *	Sudan. Fairly common in Kordofan and Darfur	
BRASSICA [Cruciferae] campestris * eruca	India India	Colza (sarson). Green fodder. Kind of mustard. Grown as winter crop in arid districts or with grain. Found wild on waste land.
CADABA [Capparidaceae] glandulosa	Sudan. Kordofan, Sennar, etc.	Good camel fodder. Bitter taste and slight purgative properties.
CALLIGONUM [Polygonaceae] polygonoides L.	India	Shoots eaten in hot weather but wither in the cold.
CAPPARIS [Capparidaceae] aphylla L.	India	Most appreciated by camels in September and October when it has a laxative effect.
decidua	Sudan. Common in Red Sea Province	The chief camel food in the vicinity of large villages like El Fasher and Medani. Of low feeding value; eaten in absence of other food.
spinosa L. tomentosa	Iraq Sudan, Nigeria	The caper bush. Excellent camel food.
CARISSA [Apocynaceae] diffusa	India	Evergreen. Leaves are enjoyed.
CASSIA [Leguminosae] kotschyana	Nigeria	
CENTAUREA [Compositae] calcitrapa	Nigeria	
CERBERA [Apocynaceae] odollam	India	
CICER [Leguminosae] arietinum *	India	Grain: used green or as concentrate and straw.
COMBRETUM [Combretaceae] aculeatum *	Sudan. Kordofan and Darfur. Nigeria	In leaf during rains. Excellent camel food, greedily eaten.
COMMIPHORA [Burseraceae] africana	Sudan	Eaten by camels, cattle and wild game.
CORDIA [Boraginaceae] abyssinica	Sudan. General throughout the middle Sudan	Excellent camel food, eaten greedily.
CODONOCARPUS [Phytolaccaceae] cotinifolia	Australia	Common grazing plant.
CYAMOPSIS [Leguminosae] psoraloides *	India	Fed green in October and November.

* See Table of Analyses.

<i>Botanical Name.</i>	<i>Area.</i>	<i>Notes.</i>
DALBERGIA [Leguminosae] sissoo	India	Leaves eaten.
DICHROSTACHYS [Leguminosae] nutans *	Sudan (middle)	The fern-like leaves are good food and readily eaten.
ERUCA [Cruciferae] sativa *	India	Green fodder. (Taramira.)
FERETIA [Rubiaceae] canthioides *	Nigeria	
FICUS [Moraceae] gnaphalocarpa *	Nigeria	
indica	India	The leaves are relished.
religiosa	India	The leaves are relished.
thonningii	Nigeria	
platyphylla	Nigeria	
GERANIUM sp. [Geraniaceae]	Iraq	
GREWIA [Tiliaceae] flavescens	Sudan	A small bush readily eaten.
GUIERA [Combretaceae] senegalensis *	Nigeria	
GYMNOSPORIA [Celastraceae] senegalensis	Sudan	Central and South of 13th parallel. Excellent camel fodder.
spinosa	India	Best months April, May, August, September.
HYPHAENE [Palmae] thebaica	Sudan	Eaten by horses, cattle and goats; sparingly by camels; little value.
INDIGOFEA [Leguminosae] pauciflora	India	
IPOMOEA [Convolvulaceae] cardiosepalala	Sudan. Butana and Tibilol districts of Kassala Province	Attractive grazing plant after first heavy rains. When first eaten it acts as a purgative.
LATHYRUS [Leguminosae] sativus *	India	"Muttur" pea. Fed green to camels in upper Sinde during February and March.
LEPTADENIA [Asclepiadaceae] heterophylla	Sudan. N. deserts of Kordofan, Darfur and Red Sea Provinces	Creeper. Excellent camel fodder.
spartum	Sudan	N. of 13th parallel. Readily eaten and is a great thirst quencher.
LORANTHUS [Loranthaceae] acaciae	Sudan	Parasite like mistletoe. Very attractive and luscious food.
LYCIUM spp. [Solanaceae]	Iraq	
MAERUA [Capparidaceae] angolensis	Nigeria	
crassifolia	Sudan. N. Kordofan and Darfur	Twigs are greedily stripped of their small leaves and are good fodder.
MALVA [Malvaceae] parviflora L.	Iraq. India	The common mallow of Iraq.
MEDICAGO [Leguminosae] denticulata	India	A weed found in April in the Central Punjab. Green fodder.
MELIA [Meliaceae] azadirachta	India	Important fodder in cold weather.
MELILOTUS [Leguminosae] parviflora *	India	Grown among wheat and fed in April to camels.

* See Table of Analyses.

<i>Botanical Name.</i>	<i>Area.</i>	<i>Notes.</i>
MERREMIA [Convolvulaceae] pedata	Somaliland, Jubaland, Sudan, Egypt	Relatively good pasture.
MORUS [Moraceae] alba L.	India	
ODINA [Anacardiaceae] barteri	Nigeria	
OLEA [Oleaceae] cuspidata	India	Wild olive; provides grazing in the stony hills in the cold weather, although it is better in the hot season.
ORTHANTHERA [Asclepiadaceae] viminea	India	Camels eat this plant only when very hungry.
PARKIA [Leguminosae] filicoidea *	Nigeria	
PHASEOLUS [Leguminosae] aconitifolius *	India	Aconite-leaved kidney bean.
mungo *	India	
vulgaris *	Sudan	
PISUM [Leguminosae] sativum *	India	
POPULUS [Salicaceae] euphratica	Iraq	Euphrates poplar.
PREMNA [Verbenaceae] resinosa	Sudan. Kordofan and Darfur, esp. in the North	A good food greedily eaten.
PROSOPIS [Leguminosae] spicigera L.	India	Best from April to June.
stephaniana Willd.	Iraq	
REPTONIA [Myrsinaceae] buxifolia	India	
RICINUS [Euphorbiaceae] communis *	Nigeria	Castor oil plant. Extracted seeds used as cake.
SALVADORA [Salvadoraceae] indica	India. Somaliland and Jubaland	Relatively good pasture.
oleoides	India	The flowers and fruit come in the dry hot weather, April and May, when the camels like it best. In the rains camels do not like it, but it is eaten since there is not much choice.
persica	Sudan, Khartoum, Berber, Nr. Kordofan, Darfur, and Red Sea Provinces	Fair camel food. Camels that are bred and reared on it are generally inferior in type.
SCLEROCARYA [Anacardiaceae] birroea	Sudan, Nigeria	The leaves and small branches are eaten readily. The fruit is like a yellow plum, sweet, and eaten by most animals.
SECURIDACA [Polygalaceae] longipedunculata *	Nigeria	
SIMARUBACEA sp. [Simarubaceae]	Somaliland and Jubaland	Great resistance to drought. Thick bright green leaves eagerly eaten. Excellent for native camels but cause serious effects in foreign camels imported in dry seasons.
STEREOSPERMUM [Bignoniaceae] kunthianum *	Sudan	Branches and leaves greedily eaten and considered by local people to be an excellent food.

* See Table of Analyses.

<i>Botanical Name.</i>	<i>Area.</i>	<i>Notes.</i>
TAMARINDUS [Leguminosae] indica	Sudan	Used by natives in treatment of fever and for quenching thirst.
TAMARIX [Tamaricaceae] mannifera Ehrbg. macrocarpa Bge. } pentandra Fall. } gallica	Iraq. French N. Africa	Provide grazing in jungles and deserts
orientalis	India	Best when in flower in the monsoon season, but eaten as long as they remain green, <i>i.e.</i> up to January.
	India	Best when in flower in the monsoon season, but eaten as long as they remain green, <i>i.e.</i> almost all the year round.
TRIBULUS [Zygophyllaceae] terrestris	Nigeria. India	Eaten after the rains.
TRIFOLIUM [Leguminosae] alexandrinum *	Egypt	A clover grown extensively on the irrigated land. Principal green feed from Feb. to the end of spring. Must be fed cautiously at first so as not to produce indigestion or excessive diarrhoea. Excellent food. Ration : 50 to 120 lbs.
resupinatum	India	Clover. Used in Peshawar after the taramira season is over.
XIMENIA [Olacaceae] americana *	Nigeria	
ZIZYPHUS [Rhamnaceae] jujuba L.*	India	Keeps green well into the cold weather if the rains have been good. Useful fodder when other keep is getting scarce.
nummularia	India	Wild jujube. Best during and after the monsoon season. Its leaves wither about December.
spina Christi *	Sudan	Good fodder and readily eaten.

GRASSES.

ANDROPOGON [Gramineae] syrtocladus Kellers	Somaliland and Jubaland.	Tall grass. Relatively good pasture.
ARISTIDA [Gramineae] adscensionis	Sudan	One of the commonest grasses eaten by all stock.
mutabilis	Sudan	A moderately good grass.
plumosa Linn.	Sudan	Good grass greedily eaten.
AVENA [Gramineae] sativa *	India	Dried green fodder.
CENCHRUS [Gramineae] catharticus	Sudan. Nigeria	Contains a good grain.
CHRYSOPOGON [Gramineae] aucheri	Somaliland. Jubaland	Strongly drought-resisting grass. Relatively good pasture.
CHLORIS [Gramineae] virgata Swartz	Sudan	North Eastern Sudan fodder.
CYNODON [Gramineae] dactylon Pers.*	Sudan	Good grass.
DACTYLOCTENIUM [Gramineae] aegyptiacum *	Sudan. Nigeria	Good feeding grass.
DIGITARIA [Gramineae] debilis	Nigeria	
ECHINOCHLOA [Gramineae] colona (Panicum colonum)	Sudan	Deccan grass. Good feeding.

* See Table of Analyses.

<i>Botanical Name.</i>	<i>Area.</i>	<i>Notes.</i>
ELEUSINE [Gramineae] flagellifera *	Sudan	Desert grass. Moderate feeding.
ENTEROPOGON [Gramineae] ruspolianum	Somaliland and Juba- land	Relatively good pasture.
ERAGROSTIS [Gramineae] aspera	Sudan	Red grass. Moderate feeding.
tremula Hochst	Sudan	Moderate feeding grass.
ISCHAEMUM [Gramineae] brachyatherum	Sudan	Excellent camel food.
ORYZA [Gramineae] punctata	Sudan	Wild rice fed green.
PENNISETUM [Gramineae] cenchröides and cenchrus carthar- ticus *	Sudan	Contains a good grain.
orientale	Somaliland and Juba- land	Relatively good pasture.
pedicellatum	Nigeria	
typhoideum *	Sudan	Bulrush millet. Common grain of the country both for man and animals.
SCHOENEFELDIA [Gramineae] gracilis	Sudan	Good feeding grass.
SORGHUM [Gramineae] vulgare *	Sudan. Somaliland	Guinea corn.
SPOROBULUS [Gramineae] somalensis	Somaliland and Juba- land	Relatively good pasture.
STIPA [Gramineae] tenacissima	French N. Africa, Egypt and Sudan	Esparto grass. Relished only when everything else is withered.
TRITICUM [Gramineae] vulgare *	India	Wheat.

SALTWORKS.

ARTHROCNEUM [Chenopodiaceae] glaucum Ung.	Iraq	
ATRIplex [Chenopodiaceae] alimus	French N. Africa	
CHENOPODIUM sp. [Chenopodiaceae]	Iraq	
HALOXYLON [Chenopodiaceae] recurvum	India	Dries up after Christmas but eaten in this state.
SALSOLA [Chenopodiaceae] foetida	India	Dries up after Christmas but eaten in this state.
kali L.	Iraq	
SCHANGINIA [Chenopodiaceae] baccata	Iraq	
SUAEDA spp. [Chenopodiaceae] fruticosa	Iraq Sudan. Red Sea Coast. India	Readily eaten. Stains teeth black.

* See Table of Analyses.

APPENDIX 2.

TABLE I.

PERCENTAGE COMPOSITION OF SOME CAMEL FODDER PLANTS: PROXIMATE PRINCIPLES AND ENERGY VALUE.

Name (Botanical).	Moisture.*	Crude Protein.	Fat.	Fibre.	Carbohydrate.	Approximate Energy Value: Cals.†	Cals. from Protein: %.	Reference no.
<i>Trees, shrubs and green fodder plants.</i>								
Acacia albida: pods	7.1	11.1	1.4	27.5	49.5	248	18	11
" " " "	—	8.82	1.44	24.40	61.74	288	13	11
" " " "	10.6	9.7	1.1	23.4	51.96	251	16	11
Acacia arabica Willd.: pods	—	12.86	2.51	15.21	63.82	317	17	11
" " " " stems and leaflets	9.6	11.7	11.4	10.2	51.29	298	16	11
Acacia sieberiana: fruits	10.9	9.8	1.0	22.0	52.71	254	16	11
Acacia spirocarpa: pods	—	12.28	1.82	22.37	57.90	288	17	11
Adansonia digitata: Baobab seeds	12.1	11.2	11.6	22.5	39.1	248	19	11
Balanites aegyptiaca Del.: leaves	10.3	10.4	3.8	12.2	51.90	264	16	11
Bauhinia reticulata: leaves	9.3	9.6	—	—	—	—	—	11
" " pods	9.8	6.3	1.8	23.6	54.58	251	10	11
Bauhinia rufescens: fruits	9.2	10.1	1.4	30.5	44.78	225	18	11
Boscia sp.: leaves	8.8	18.4	1.4	29.0	36.74	226	33	11
Brassica campestris: green fodder (saron)	80.13	2.00	0.47	3.14	4.64	28	29	27
" " dried green fodder	10.00	13.00	3.05	20.41	30.16	185	29	27
Cicer arietinum L.: chick peas (grain)	8.78	22.8	4.87	3.54	57.12	339	28	11
" " " "	9.58	16.95	5.25	8.32	56.13	313	22	11
" " " "	8.60	14.64	4.03	1.93	48.49	—	—	—
" " " "	to	to	to	to	to	310	24	27
" " " "	17.21	22.81	5.94	12.20	60.93	—	—	—
" " " chuni	8.36	17.13	3.90	8.34	56.34	309	23	27
" " " "	8.65	18.13	4.09	7.95	55.96	313	24	27
" " " husks	13.42	3.75	0.40	42.24	35.97	160	10	27
" " " "	11.16	5.91	0.94	37.23	40.53	190	13	27
Cicer arietinum: husk (thoth)	4.89	6.45	4.34	11.31	68.11	316	8	27
" " " "	6.56	2.87	1.26	19.93	38.84	—	—	—
" " " " " " " "	to	to	to	to	to	200	7	27
" " " " " " " "	11.43	4.46	3.08	40.40	51.37	—	—	—
" " " grain with pods	—	9.37	2.27	21.72	44.92	275	—	13
" " " " " " " "	—	to	to	to	to	—	—	—
" " " green fodder	—	19.94	4.06	27.27	56.93	219	23	13
" " " " " " " "	—	12.06	1.97	33.91	40.69	244	16	13
Combretum sp.: leaves	8.4	9.69	2.21	32.18	49.15	—	—	11

* The figures given in the Moisture column represent the moisture content of the sample(s) analysed except for those in Ital., where the moisture is that of the fresh sample(s) and the other constituents are given as percentages of dry matter.

† Calculated as (Protein + Fat + Carbohydrate) × 4.

TABLE I.
PERCENTAGE COMPOSITION OF SOME CAMEL FODDER PLANTS: PROXIMATE PRINCIPLES AND ENERGY VALUE—(continued).

Name (Botanical).	Moisture.*	Crude Protein.	Fat	Fibre.	Carbohydrate.	Approximate Energy Value: Cals.†	Cals. from Protein: %.	Reference no.
<i>Trees, shrubs and green fodder plants.</i>								
Cyamopsis psoraloides	{ 8.99 to 10.67	25.09 to 28.31	2.63 to 3.36	3.13 to 8.49	47.94 to 56.10	330	33	27
" " green guara	—	11.99	1.45	33.85	37.85	205	24	13
Dichrostachys nutans: beans	7.08	18.55	2.07	20.27	47.44	272	28	11
" " fruits	9.9	10.7	0.8	22.20	51.38	252	17	11
Feretia canthioides: leaves	8.2	4.8	—	—	—	—	—	11
Ficus gnaphalocarpa: leaves	11.6	13.8	—	—	—	—	—	11
Guiera senegalensis: leaves	7.9	8.8	—	—	—	—	—	11
Lathyrus sativus: grain	7.89	24.69	0.79	4.28	57.98	334	30	27
" " bhusa	6.10	9.75	5.00	19.36	45.39	241	17	27
" " "	11.08	9.25	2.93	20.57	43.03	221	17	27
Melilotus parviflora: green food	84.40	2.69	0.36	4.13	6.16	37	30	27
" " dried green fodder	10.00	15.52	2.08	23.83	35.54	213	30	27
Parkia filicoidea: Dawa Dawa seeds	10.1	28.5	16.8	8.3	32.4	311	38	11
" " Dawa Dawa powdery material and seeds	12.14 9.35	14.70 16.0	8.39 6.14	10.74 11.0	50.07 52.73	293 299	21 22	11 11
Phaseolus aconitifolius: grain	{ 7.46 to 13.78	17.00 to 22.50	0.67 to 1.07	3.83 to 5.73	58.85 to 63.55	330	25	27
" " bhusa	8.78	12.13	2.80	14.20	47.12	248	20	27
" " green fodder	74.70	3.20	0.89	4.99	12.00	64	21	27
" " dried green fodder	10.00	11.36	3.16	17.71	42.60	228	20	27
" " Moth, hay	—	10.59	1.85	26.75	45.06	230	19	13
Phaseolus mungo L.: beans	8.02	27.0	1.20	3.83	56.31	338	33	11
" " " grain	{ 8.14 to 11.67	18.50 to 22.81	0.82 to 1.13	3.27 to 4.79	57.52 to 60.82	320	26	27
" " " bhusa	8.97	6.13	1.13	10.62	35.82	183	14	27
" " " chuni	{ 15.96 to 7.75	14.50 to 21.41	2.56 to 3.03	32.58 to 6.61	44.11 to 49.27	245 295	24 30	27 27
Phaseolus vulgaris L.: beans	7.58	23.57	1.63	3.75	59.12	337	29	11

* The figures given in the Moisture column represent the moisture content of the sample(s) analysed except for those in Ital., where the moisture is that of the fresh sample(s) and the other constituents are given as percentages of dry matter.

† Calculated as (Protein + Fat + Carbohydrate) $\times$ 4.

TABLE I.
PERCENTAGE COMPOSITION OF SOME CAMEL FODDER PLANTS: PROXIMATE PRINCIPLES AND ENERGY VALUE—(continued).

Name (Botanical).	Moisture.*	Crude Protein.	Fat.	Fibre.	Carbohydrate.	Approximate Energy Value: Cals.†	Cals. from Protein, %.	Reference no.
<i>Grasses.</i>								
Eleusine flagellifera : Chimbar grass	{ —	9.99 to 14.75	1.08 to 1.90	30.39 to 35.42	37.54 to 42.26	220	23	13
Pennisetum cenchroides : Anjan grass	{ —	3.00 to 10.70	0.97 to 2.30	27.46 to 43.62	40.36 to 56.84	230	—	13
Pennisetum typhoides : Bajra, green	—	11.88	1.18	29.68	44.68	231	21	13
" " Rich	12.83	12.47	5.0	2.80	67.13	338	15	11
Sorghum vulgare grain (white)	13.50	9.90	—	—	—	—	—	11
" " (red)	7.01	11.06	—	—	—	—	—	11
Triticum vulgare : straw	{ 12.27	1.44 to 3.75	0.74 to 1.90	19.18 to 45.93	35.33 to 49.80	180	5	27
" " green fodder	82.65	1.87	0.40	5.07	7.56	39	20	27
" " dried green fodder	10.01	9.70	2.07	26.31	39.24	204	19	27
<i>Saltsorts.</i>								
Atriplex capensis	{ 62.44 to 82.35	18.38 to 26.77	1.16 to 3.11	7.95 to 14.71	31.38 to 42.53	251	37	10
" nummularia	{ 61.10 to 75.04	17.81 to 25.59	1.55 to 3.00	8.77 to 13.92	39.75 to 48.10	285	31	10
" semibaccata	{ 59.39 to 79.84	13.30 to 22.97	1.07 to 2.08	11.61 to 22.33	17.97 to 48.28	239	31	10
" halimoides	{ 39.99 to 90.02	9.71 to 21.53	1.74 to 2.89	12.61 to 24.55	26.88 to 45.20	224	29	10
Salsola aphylla	{ 61.14 to 81.38	11.90 to 26.25	1.34 to 3.04	9.03 to 28.52	21.46 to 52.65	226	35	10
" glabrescens	{ 45.28 to 76.32	12.43 to 25.46	1.22 to 2.36	12.45 to 18.93	39.00 to 52.23	275	28	10

* The figures given in the Moisture column represent the moisture content of the sample(s) analysed except for those in Ital., where the moisture is that of the fresh sample(s) and the other constituents are given as percentages of dry matter.

† Calculated as (Protein + Fat + Carbohydrate) × 4.

TABLE 2.

COMPOSITION OF SOME CAMEL FODDER PLANTS: ASH CONSTITUENTS PER CENT.

Name.	Moisture.*	Total Ash.	Sol. Ash.	Ca.	P.	Na.	Cl.	Potential NaCl.	Reference no.
<i>Trees, shrubs and green fodder plants.</i>									
Acacia albida pods . .	—	3.60	3.26	0.65	0.23	—	—	—	II
„ arabica pods . .	—	5.60	5.21	0.51	0.14	—	—	—	II
„ spirocarpa pods . .	—	5.63	5.13	0.98	0.24	—	—	—	II
Bauhinia reticulata pods .	9.8	3.92	3.85	0.36	0.13	0.07	0.007	0.012	II
Cicer arietinum (grain) . .	9.58	3.77	3.25	0.27	0.25	0.02	0.149	0.050	II
„ „ (grain with pods)	—	5.91 to 13.30	—	0.97 to 2.07	0.21 to 0.27	0.02 to 0.20	—	—	13
„ „ (green fodder) .	—	11.37	—	1.72	0.21	0.72	—	—	13
„ „ „ „	—	6.77	—	0.84	0.24	0.55	—	—	13
Cyamopsis psoraloides (green guara)	—	14.86	—	2.38	0.16	0.31	0.230	0.380	13
Phaseolus aconitifolius (hay) .	—	13.75	—	2.33	0.18	0.65	4.460	1.650	13
<i>Grasses.</i>									
Avena sativa (hay) . .	—	6.13 to 10.71	—	0.24 to 0.45	0.10 to 0.33	0.16 to 1.17	0.270 to 1.980	0.410 to 2.970	13
Cynodon dactylon . . .	57.0	8.48 to 13.41	3.22 to 9.15	0.26 to 0.59	0.10 to 0.38	0.06 to 0.40	0.330 to 0.710	0.150 to 1.020	9
Dactyloctenium aegypt. .	—	14.50 to 11.30	10.29 to —	1.02 to 0.56	0.23 to 0.20	1.39 to 0.54	2.010 to —	3.310 to —	9
Eleusine flagellifera . .	—	13.95 to 9.14	—	0.79 to 0.31	0.33 to 0.18	0.93 to 0.07	—	—	13
Pennisetum cenchroides . .	—	20.85 to 12.58	—	1.36 to 0.47	0.41 to 0.33	1.28 to 0.41	—	—	13
„ typhoideum . .	—	12.83	—	0.47	0.33	0.41	1.11	1.040	13
Sorghum vulgare (grain white)	12.83	1.62	1.52	0.01	0.31	0.01	0.04	0.030	II
„ „ („ red)	13.50	1.51	1.45	0.01	0.27	0.01	0.05	0.030	II
<i>Saltworts.</i>									
Atriplex capensis . . .	62.44 to 82.35	22.68 to 29.37	20.74 to 27.53	0.74 to 1.49	0.16 to 0.34	4.24 to 8.48	2.74 to 5.62	7.110	10
„ nummularia . . .	61.10 to 75.04	18.84 to 24.95	18.04 to 25.65	0.89 to 1.73	0.13 to 0.30	4.29 to 7.28	2.52 to 4.37	5.920	10
„ semibaccata . . .	59.39 to 79.84	15.38 to 30.00	11.22 to 22.92	1.19 to 2.27	0.07 to 0.21	3.70 to 5.82	2.70 to 6.04	6.65	10
„ halimoides . . .	39.99 to 90.02	18.80 to 31.14	17.01 to 29.31	1.06 to 2.18	0.07 to 0.28	4.01 to 7.71	3.69 to 9.30	8.96	10
Salsola glabrescens . . .	45.28 to 76.32	13.07 to 18.28	12.29 to 17.34	1.34 to 2.66	0.10 to 0.23	0.76 to 2.64	0.91 to 1.82	2.440	10
„ aphylla . . .	61.14 to 81.38	16.78 to 31.15	14.31 to 29.16	1.12 to 3.33	0.09 to 0.22	1.44 to 7.98	1.16 to 2.27	3.040	10

* See footnote to Table 1.

TABLE 3.

PERCENTAGE COMPOSITION AND DIGESTIBILITY OF FOODS USED IN CAMEL RATIIONS.

Name of Foodstuff.	Chemical Analysis.					Digestible Constituents.							References. \\
	Moisture.	Protein.	Fat.	Fibre.	CHO.	Protein.	Fat.	Fibre.	CHO.	Calorie Value.	Cals. from Protein : %.		
Barley . .	14.90	8.60	1.50	4.50	67.90	6.5	1.20	2.50	62.20	303	8.8	31	
Barley meal .	12.60	11.90	2.20	4.60	65.50	8.8	2.00	1.10	60.10	307	11.8	31	
Bean . .	14.30	25.40	1.50	7.10	48.50	20.10	1.20	4.10	44.10	291	28.3	31	
Gram (Cicer arietinum) .	11.00	23.40	1.10	5.10	54.30	14.70	2.70	2.90	50.50	304	19.8	31	
Maize . .	13.00	9.90	4.40	2.20	69.20	7.10	3.90	1.30	65.70	340	8.6	31	
Millet . .	12.50	10.60	3.90	8.10	61.10	8.00	3.10	2.70	45.80	261	12.6	31	
Oats . .	13.30	10.30	4.80	10.30	58.20	7.20	4.00	2.60	44.80	261	11.3	32	
Oat bran . .	9.50	8.00	3.60	21.90	51.00	4.00	2.00	8.10	35.60	214	7.7	31	
Wheat bran .	13.60	13.50	3.90	10.60	53.00	10.60	2.80	2.80	38.00	237	18.3	31	
Cotton seed (Bombay) .	8.50	17.90	19.40	20.00	29.90	12.30	16.80	15.20	15.00	330	15.3	31	
Sesame oilcake .	9.30	44.50	11.90	4.50	20.90	40.00	10.70	1.40	11.70	317	51.7	31	
Barley straw or tibbon .	14.00	3.30	1.80	33.90	42.40	0.80	0.60	18.30	22.50	177	1.9	31	
Gram bhusa (Missa bhusa) .	9.40	5.44	0.48	40.27	32.35	2.18	(0.17)	16.15	15.29	139	6.1	16	
Millet chaff and husks . .	12.00	4.80	2.20	40.80	29.00	1.70	0.70	15.10	13.60	131	5.3	31	
Wheat straw .	14.00	2.10	1.30	36.60	40.70	—	0.40	18.30	15.00	140	—	32	
Green sarson (Brassica campestris) .	85.13	1.29	0.42	4.01	6.86	0.84	0.31	1.36	3.64	27	12.8	14	
Hay (Punjab) .	7.40	3.25	0.92	37.14	43.74	0.88	0.31	24.91	17.74	181	2.0	15	
Hay (good meadow) .	14.30	9.70	2.50	26.30	41.00	3.80	1.00	15.00	25.70	192	8.1	32	
Turnips . .	91.50	1.00	0.20	0.90	5.70	0.20	—	0.30	5.20	23	3.6	32	

APPENDIX 3.

TABLE 4.

RATIONS EATEN BY RESTING CAMELS IN ADDITION TO POOR GRAZING.

FODDER AND TURNIPS FED "AD LIB." (CROSS.)

(Analysis Based on Table 3.)

Food.	Amount, lb.	Protein, g.	Fat, g.	Total Carbohydrate, g.	Energy Value, 1000 Cals.	Calories from Protein, %.
Gram . . .	12	800	147	2907	16.5	
Missa bhusa .	20.6	204	16	2938	13.0	
		1004	163	5845	29.5	13.9
Gram . . .	6	400	73	1453	8.3	
Missa bhusa .	23.1	228	18	3294	14.5	
		628	91	4747	22.8	11.3
Missa bhusa .	24.9	246	19	3551	15.7	6.4
Gram . . .	6	400	74	1453	8.3	
Moth bhusa *	26.7	107	37	5166	21.9	
		507	111	6619	30.2	6.9
Moth bhusa *	29.9	119	42	5784	24.5	2.0
Barley . . .	5	147	27	1467	6.9	
Turnips . . .	26.6	24	—	664	2.8	
Moth bhusa *	26.4	106	37	5107	21.7	
		277	64	7238	31.4	3.6
Gram . . .	6	400	73	1453	8.3	
Green taramira †	66.1	252	93	1499	8.1	
		652	166	2952	16.4	16.3
Green sarson .	135.4	516	190	3071	16.6	12.8
Gram . . .	6	400	73	1453	8.3	
Hay . . .	16.2	65	23	3134	13.3	
		465	96	4587	21.6	8.8

* Taken as Punjab hay.

† Taken as green sarson.

TABLE 5.

RATIONS PROPOSED BY LEESE.

(Analysis based on Table 3.)

Foodstuff.	Amount, lb.	Protein, g.	Fat, g.	Total CHO, g.	Energy Value, 1000 Cals.	Cals. from Protein, %.	Notes.
Gram . . .	4	267	49	969	5.5		No grazing. Working Indian or Egyptian baggagees.
Missa bhusa *	30	297	23	4278	19.0		
		564	72	5247	24.5	9.5	
Gram . . .	6	400	74	1453	8.3		Grazing poor or none. Indian baggagees in Somaliland.
Hay . . .	25	100	35	4836	20.5		
Gur . . .	1	—	—	445	1.8		
		500	109	6734	30.6	6.7	
Millet . . .	7½	272	105	1650	8.9		Alternative to preceding ration.
Tibben . . .	16	58	44	2961	12.8		
Gur . . .	1	—	—	445	1.8		
		330	159	5056	23.5	5.8	
Barley meal .	7	280	64	1943	9.8		Grazing poor or none. Working baggagees in Asia Minor.
Tibben . . .	45	163	122	8328	36.1		
		443	186	10271	45.9	4.0	
Gram . . .	4	267	49	969	5.5		Grazing poor or none. Working Somali or Aden camels.
Hay † . . .	20	80	28	3869	16.4		
		347	77	4838	21.9	6.5	
Gram . . .	7	467	86	1696	9.7		No grazing. Riding camels : hard work.
Gur . . .	1½	—	—	667	2.7		
Missa bhusa *	{ 20	198	15	2852	12.6		
or . . .		or	or	or	or		
hay . . .		80	28	3869	16.4		
		666	101	5215	25.0	9.0	
		or	or	or	or	or	
		547	114	6232	28.8	7.8	
Cotton seed .	5	279	381	685	7.5		No grazing. Riding camels : Aden.
Oil cake . .	5	907	243	297	7.2		
Millet chaff .	25	193	79	3255	14.8		
		1379	703	4237	29.5	19.2	

* Taken as gram bhusa.

† Taken as Punjab hay.

TABLE 5.

RATIONS PROPOSED BY LEESE—(continued).

(Analysis based on Table 3.)

Foodstuff.	Amount, lb.	Protein, g.	Fat, g.	Total CHO, g.	Energy Value, 1000 Cals.	Cals. from Protein, %.	Notes.
Gram . . .	6	400	74	1453	8.3		A little grazing. Working Indian or Egyptian baggagees.
Missa bhusa *	20	198	15	2852	12.6		
		598	89	4305	20.9	11.7	
Crushed beans .	2	182	11	437	2.6		A little grazing. Riding camels : hard work.
Millet . . .	4	145	56	880	4.7		
Gram . . .	4	267	49	969	5.5		
Tibben . . .	12	44	33	2221	9.6		
		638	149	4507	22.4	11.7	
Millet . . .	8	290	113	1760	9.5		A little grazing. Riding camels.
Tibben . . .	14	51	38	2591	11.2		
		341	151	4351	20.7	6.8	
Millet . . .	8	290	113	1760	9.5		Fair grazing. Working Indian baggagees.
Tibben . . .	10	36	27	1851	8.0		
		326	140	3611	17.5	7.7	
Gram . . .	4	267	49	969	5.5		Several hours grazing. Indian baggagees.
Barley . . .	2	59	11	587	2.8		
		326	60	1556	8.3	16.2	
Millet . . .	4	145	56	880	4.7		Full grazing. Riding camels : Jubaland.
Maize . . .	2	64	36	608	3.1		
Simsim oil cake .	2	363	97	119	2.9		
		572	189	1607	10.7	21.9	
Oats or other grain (as millet) . . .	{ 2 or 3	{ 73 or 108	{ 28 or 42	{ 440 or 660	{ 2.4 or 3.6	{	Resting camels. Shipboard or Zoo.
	{ 30 or 20	{ 80 or 53	{ 28 or 19	{ 3869 or 2581	{ 26.0 or 17.4	{	
Good hay . . .							
		153 or 161	56 or 61	4309 or 3241	28.4 or 21.0	22.1 or 31.4	

* Taken as gram bhusa.

TABLE 6.

RATIONS USED BY CAMEL CORPS AND NATIVE CAMEL OWNERS WITH ONE PROPOSED BY
LENOX-CONYNGHAM.

(Analysis Based on Table 3.)

Food.	Amount.	Protein, g.	Fat, g.	Total CHO, g.	Energy Value, 1000 Cals.	Cals. from Protein, %.	Notes.
Split gram .	4 lb.	267	49	969	5.5	—	With grazing. Somaliland Camel Corps
Wheat bran .	2 „	96	25	370	2.2	—	
Hay .	10 „	40	14	1935	8.2	—	
		403	88	3274	15.9	10.4	
Split gram .	2 lb.	133	25	484	2.8	—	Experimental ration used by Peck as alternative to above
Sorghum .	2 „	73	28	440	2.4	—	
Wheat bran .	2 „	96	25	370	2.1	—	
Hay .	10 „	40	14	1935	8.2	—	
		342	92	3229	15.5	9.0	
Barley . .	3 kg.	195	36	1941	9.1	—	Trans-Jordan Frontier Force
Hay . .	5 „	44	16	2133	9.1	—	
Barley straw .	3 „	24	18	1224	5.3	—	
		263	70	5298	23.5	4.6	
Wheat straw .	10.7 lb.	—	19	1616	6.8	—	Indian Government fodder ration
Missa bhusa .	5.3 „	52	4	756	3.3	—	
		52	23	2372	10.1	2.1	
Barley . .	3 kg.	195	36	1941	9.1	—	Fellahin : Palestine
Straw . .	8.5 kg.	68	51	3468	15.0	—	
		263	87	5409	24.1	4.5	
Barley . .	5 kg.	325	60	3235	15.1	—	Transport contractors, Iraq. Camels in full work : grazing scarce
Straw . .	7 „	56	42	2856	12.4	—	
		381	102	6091	27.5	5.7	
Grain (as barley)	6 lb.	177	33	1761	8.2	—	No grazing. Lenox-Conyngham
Hay . .	50 „	200	70	9673	41.1	—	
		377	103	11434	49.3	3.1	

TABLE 7.

CONCENTRATION OF SALT IN TOTAL WATER OF RATIONS.

	Added NaCl, g.	Total NaCl, g.	Preformed Water, g.	Potential Water, g.	Added Water, g.	Total Water, g.	Total NaCl as percentage of Total Water.
<i>Dry ration :</i>							
Gram 6 lb., hay 16.2 lb. .	Nil	52	843	3035	Nil	3,878	0.13
1½ oz. salt } . .	42	94	—	—	13,608	17,486	0.54
3 gal. water } . .	42	94	—	—	36,288	40,166	0.23
1½ oz. salt } . .	142	194	—	—	13,608	17,486	1.11
8 gal. water } . .	142	194	—	—	36,288	40,166	0.48
5 oz. salt } . .							
3 gal. water } . .							
5 oz. salt } . .							
8 gal. water } . .							
<i>Fresh fodder :</i>							
Green sarson, 135.4 lb. .	—	28	52,285	2239	—	54,524	0.05
Salsola glabrescens, 20 lb.	89	117	5,454	1414	—	61,392	0.19
Salsola aphylla, 36.1 lb.	135	163	11,964	1363	—	67,851	0.24
Atriplex capensis, 32.2 lb.	283	311	10,631	1414	—	66,569	0.47
Atriplex halimoides, 29.3 lb	400	428	8,806	1290	—	64,620	0.66
<i>Saltwort alone :</i>							
Salsola glabrescens : 100 g.	—	1.0	60	16	—	76	1.3
„ aphylla : 100 g. .	—	0.8	73	8	—	81	1.0
Atriplex capensis : 100 g. .	—	1.9	73	10	—	83	2.3
„ halimoides : 100 g.	—	3.0	66	10	—	76	3.9

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